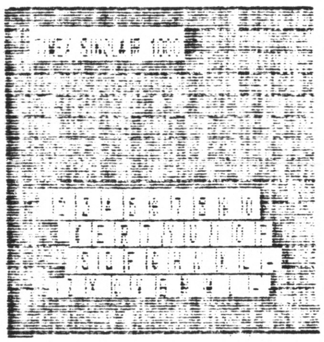
CAPITAL DISTRICT TIMEX/SINCLAIR COMPUTER CLUB

ALBANY, NEW YORK



OUR CLUB MEETINGS ARE HELD AT THE CAPITAL DISTRICT PSYCHIATRIC CENTER, 75 NEW SCOTLAND AVENUE, ALBANY, NEW YORK IN ROOM 37. OUR MEETINGS ARE NOW HELD FOUR TIMES A YEAR, FEBRUARY, MAY, AUGUST AND NOVEMBER ON THE THIRD WEDNESDAY OF THE MONTH AT 7:30 - 10 PM.

FOR INFORMATION, COMMENTS OR CONTRIBUTIONS TO THE NEWSLETTER PLEASE CONTACT CLUB PRESIDENT FRED LEWIS, 5 SHERWOOD PARK DR., BURNT HILLS, NY 12027, TELEPHONE (518) 399 5038

As reported in our May, 1991 NEWSLETTER our club has changed meeting times from monthly to quarterly. This was because of reduced membership and the resulting problems of getting full programs. Accordingly our next scheduled meeting was for August. What with vacations and Summer slowdowns we have not arranged for an August program and so we will cancel the August meeting.

To give you something to look at I have attached some abridged hand-out sheets from the February and May meeting programs which included some presentations on computer models and especially the applications of fractal technology to real-life systems. Although the poop sheets are not all self explanatory, just program props, they may provide interesting reading and some references.

MEETING HANDOUTS: There has been a phenomenal increase in interest, research and practical applications of chaotic phenomena in the last ten years. One field especially, the application of chaotic theory to chemical catalysis, was represented by about one thousand abstracted papers in the year 1988 as reported in the book (a symposium) THE FRACTAL APPROACH TO HETEROGENEOUS CHEMISTRY, Surfaces, Colloids, Polymers, Edited by D. Avnir, Wiley. The attached (abridged) handouts were used in programs on the applications of fractal technology to computer modeling.

ON RANDOM NUMBERS, MODELS, COMPUTER ERRORS, FRACTALS and CHAOS

A model simulates the workings of a device or system so study is facilitated. The model may be real (a device) or a computer simulation.
A model can represent anything: weather, market model, explosions, jets, air foils or chemical reactions. Try globular star clusters.

Laplace (1776): "With enough information I can predict the future of the universe for all time, knowing the position and vectors of every atom".

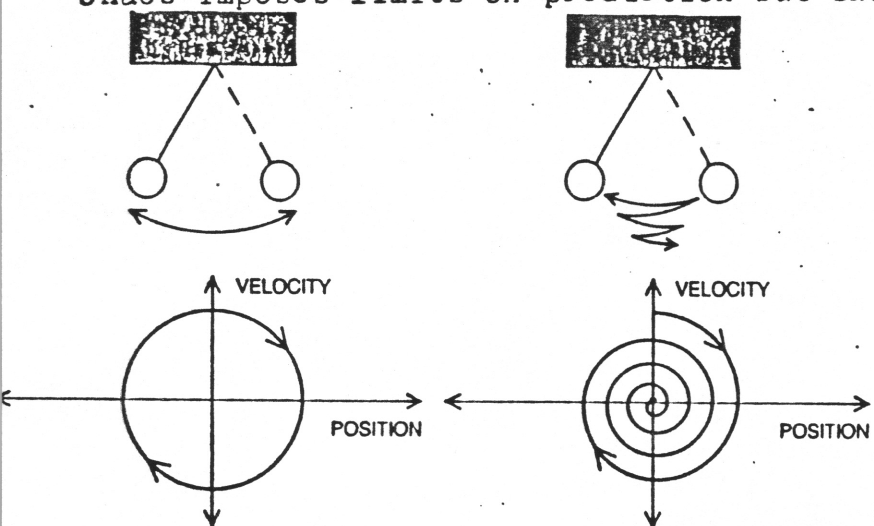
Poincaré (1903): Originated dynamical systems and foresaw unpredictable results from catastrophic amplification of small errors.

Lorenz (1963): Discovered the first example of chaotic states produced by deterministic equations.

Several authors (1970's): Revolutionary applications in understanding and control of chaotic systems. (Fractals is just one branch).
NEW →

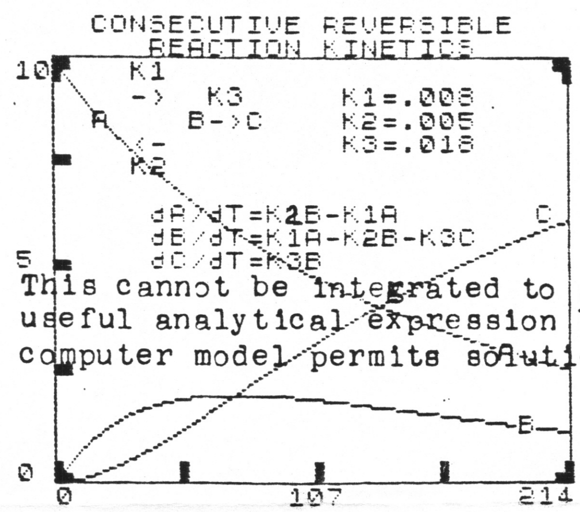
Simple, non-linear deterministic equations may develop equilibrium, several equilibrium states or explode into chaos. We can't predict. This profoundly influences the use of such models.

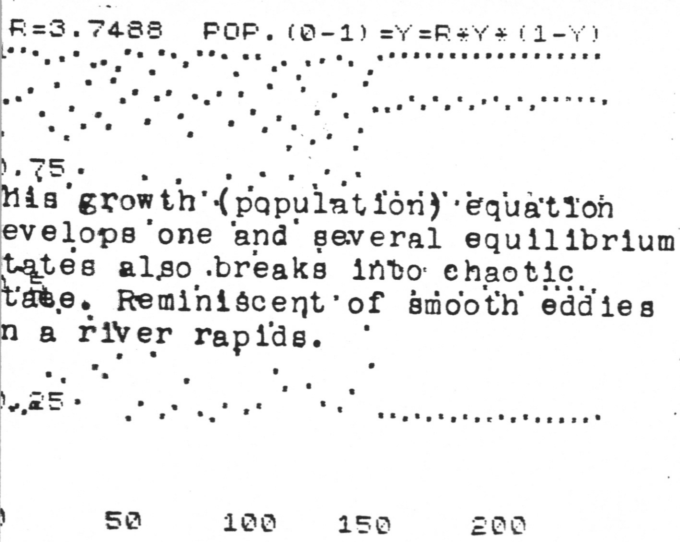
There is order in chaos and randomness has underlying geometric form. Chaos imposes limits on prediction but shows causal relations (new stuff).

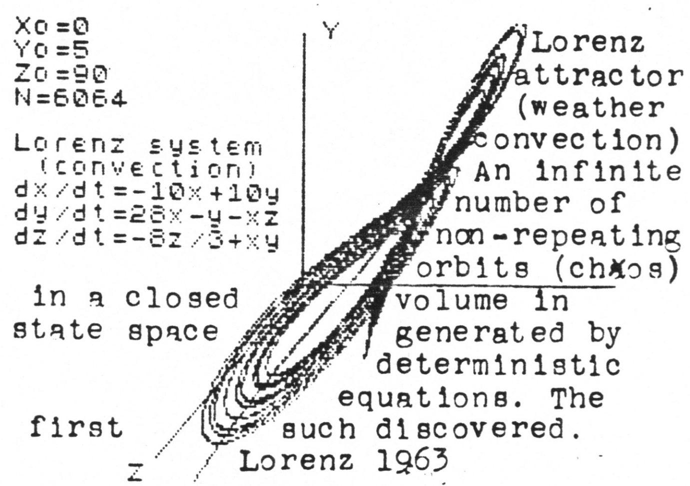


STATE SPACE is a useful concept for visualizing the behavior of a dynamical system. It is an abstract space whose coordinates are the degrees of freedom of the system's motion. The motion of a pendulum (*top*), for example, is completely determined by its initial position and velocity. Its state is thus a point in a plane whose coordinates are position and velocity (*bottom*). As the pendulum swings back and forth it follows an "orbit," or path, through the state space. For an ideal, frictionless pendulum the orbit is a closed curve (*bottom left*); otherwise, with friction, the orbit spirals to a point (*bottom right*).

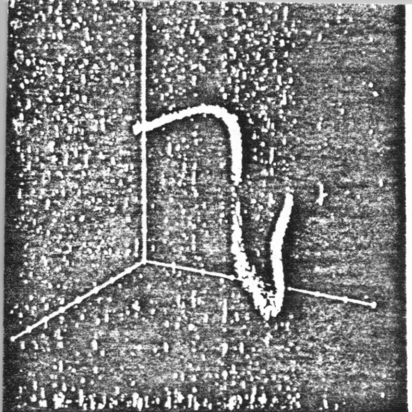
EXAMPLES OF MODELS





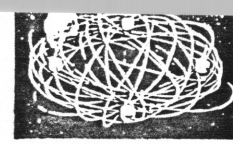


AFTER 500,000 LOOPS (NOT SHOWN)
THE 2068 STILL GENERATES NEW ORBITS

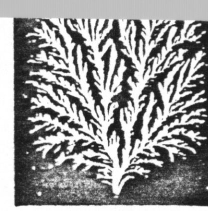


DRIPPING WATER ATTRACTOR
PLOT OF SEQUENTIAL DROP TIMES IS "ORDERED"

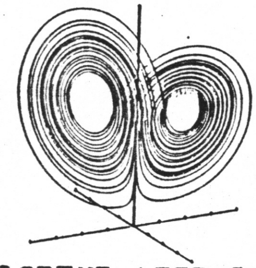
STIRRED PAINT
ORDER (REPEATED) WITHIN CHAOS



CHAOTIC PENDULUM



SPARK DISCHARGE



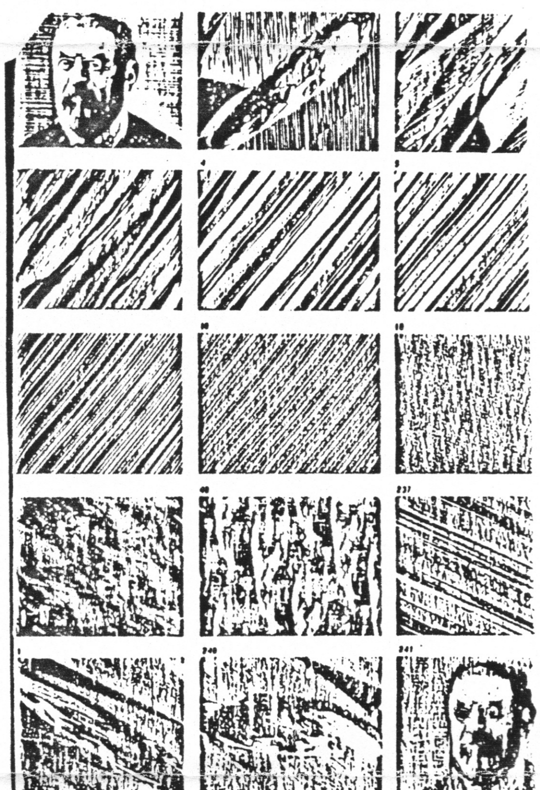
LORENZ ATTRACTOR WEATHER MODEL

MICROCLUMPING OF CELLS

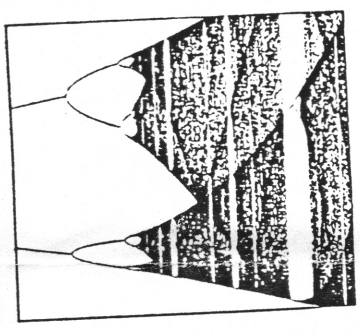
SOME NATURAL AND MAN MADE ATTRACTORS AND CHAOTIC FORMS

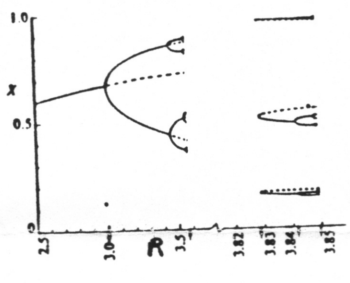
THE GREAT RED SPOT

IMAGE STRETCHED AND TWISTED MANY TIMES BY COMPUTER



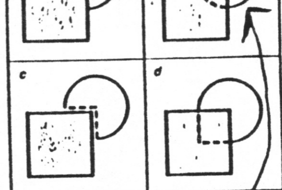
AN IMAGE IS SOMEHOW PRESERVED IN THE CHAOS OF A DOUBLY STRETCHED AND TWISTED IMAGE





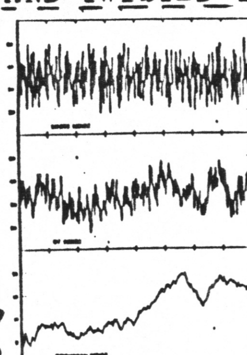
BIFURCATION MAP OF TRIGGERED CHAOS
POPULATION GROWTH BY DETERMINISTIC EQUATION:
X=RX(1-X) ->CHAOS FOR R>3.85

MENTAL IMAGE PROCESSING, THE MIND SEES BUMPS/HOLES (TURN UPSIDE DOWN)



AND SUPPLIES MISSING IMAGE ELEMENTS

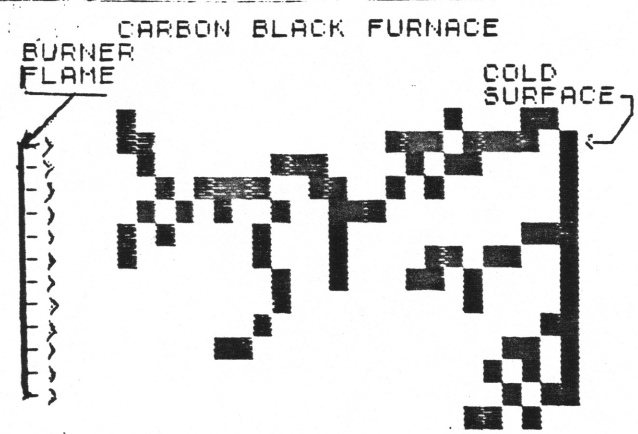
WHITE NOISE →
1/f NOISE (FRACTAL) →
BROWNIAN NOISE →



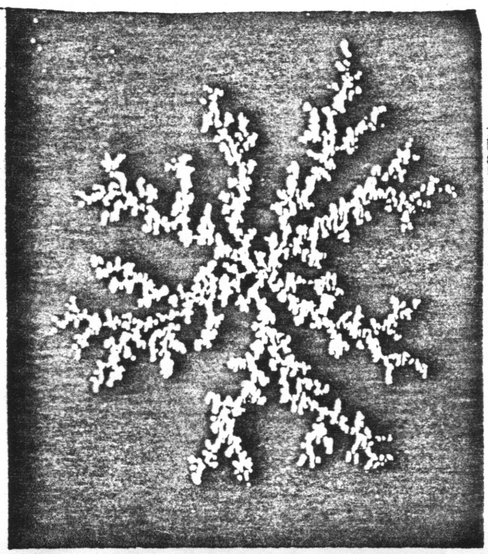
FRACTAL SOUND

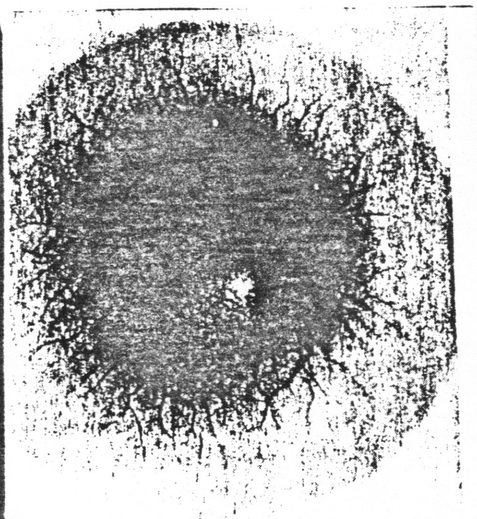
EXAMPLES OF REAL AND SIMULATED FRACTAL PATTERNS

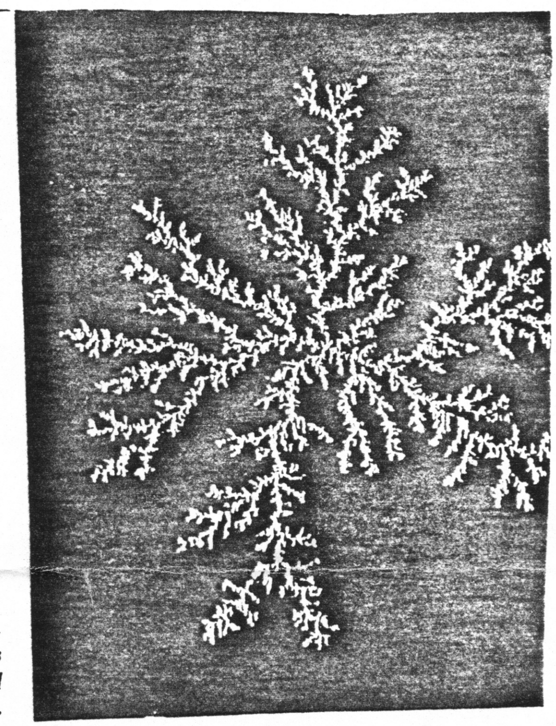
AT RIGHT WE SIMULATE THE DIFFUSION LIMITED GROWTH OF A VERY OPEN CARBON BLACK STRUCTURE. ACTUAL EXAMPLES MIGHT HAVE A CLUSTER SIZE OF 200 ANGSTROMS AND A SURFACE AREA OF 1000 SQ. METERS PER GRAM. (ABOUT ONE SQ. MILE OF SURFACE PER HAT FULL.) THIS SIMULATION OF THE GROWTH OF A CLUSTER OF CARBON BLACK ATOMS BY DIFFUSION WAS CREATED ON A TS1000 BY A PROGRAM WHICH IMITATED DIFFUSION. PLOT POINTS (ATOMS) WERE GENERATED RANDOMLY ALONG THE "BURNER" (LEFT) AND THESE MOVED RANDOMLY UNTIL CAPTURED BY CONTACTING THE CLUSTER.

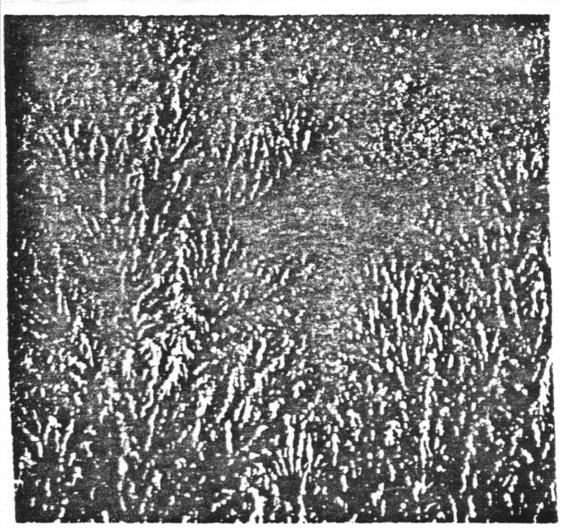


EXAMPLES FROM REVIEW ARTICLE "FRACTALS OFFER MATHEMATICAL TOOL FOR STUDY OF COMPLEX CHEMICAL SYSTEMS" (CHEMICAL AND ENGINEERING NEWS, APRIL 22, 1991).



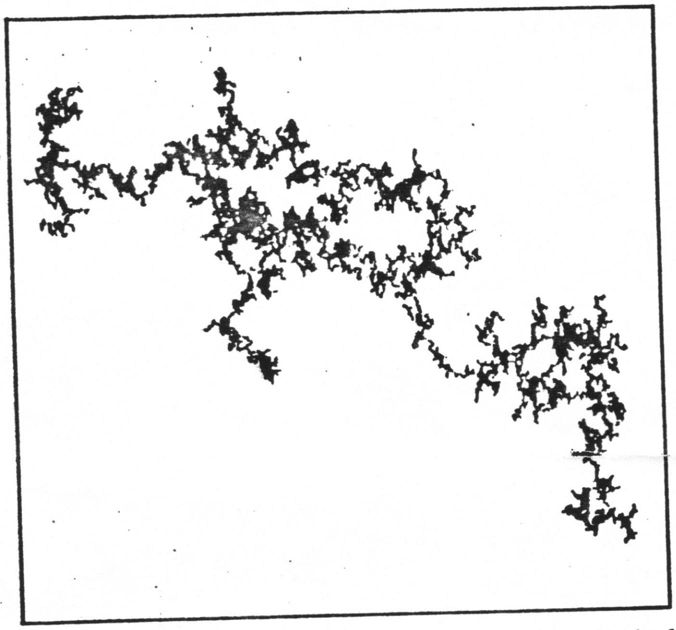


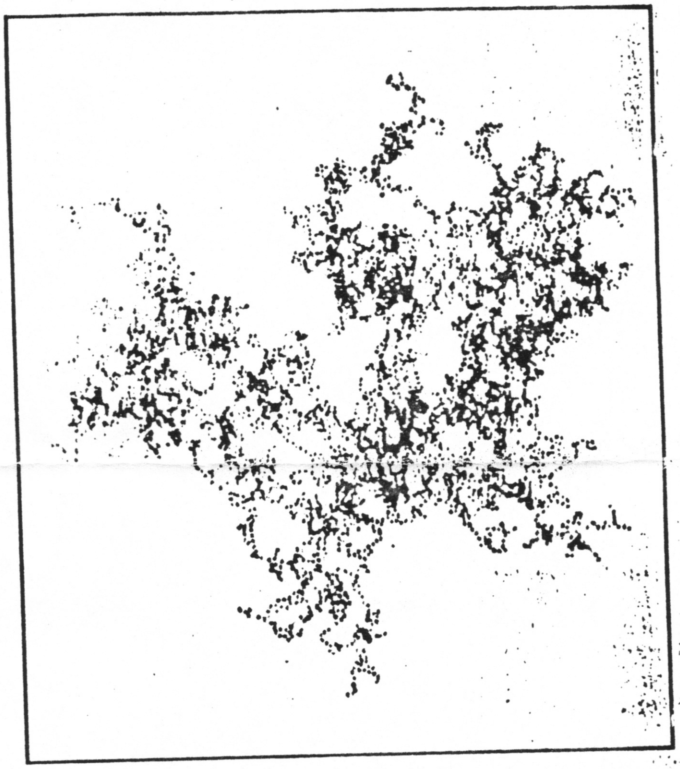




Similar fractal patterns are seen in viscous fingering process (injection of air into thin oil layer, upper left), manganese dioxide crystal structures on an ancient rock (lower left), and retinal blood vasculature (above). This type of pattern has been shown to arise from same diffusion-limited aggregation model used to create computer simulation (right). Retina reprinted from Physica D, 38, 98 (1989). Viscous fingering and simulation reprinted from Computers in Physics, 4, 44 (1990)

PRACTICAL APPLICATIONS OF FRACTAL TECHNOLOGY TO CHEMICAL REACTION KINETICS AND CHEMICAL MANUFACTURING PROCESSES WERE DESCRIBED IN A RECENT REVIEW (CHEMICAL & ENGINEERING NEWS, APRIL 22, 1991).





Computer-simulated cluster from diffusion-limited aggregation model (above) and electron micrograph of gold colloid (right) appear similar and have been shown to have the same fractal properties. Simulation reproduced from Ann. Rev. Phys. Chem., *39, 237 (1988)*

The model is applicable, he says, to several industrial processes in which porous media are involved, including combustion of coal particles, filtration processes, and oil recovery operations from underground reservoirs.

Fractals are also proving useful for modeling surfaces of electrodes. Meakin and Bernard Sapoval, head of the Condensed Matter Laboratory at Ecole Polytechnique, Palaiseau, France, have been studying frequency responses at rough electrode surfaces, a phenomenon called constant phase-angle behavior. "This has been something of a mystery for the past few decades," says Meakin, "and suggestions have been put forward as to what its origin is. At the present time that's not completely clear. One possible explanation is that the surfaces of rough electrodes are fractals and this is responsible for this kind of behavior at the electrode-electrolyte interface. This is an area where we're developing ideas, developing understanding."

Another important area for application of fractal concepts is in studies of the kinetics of heterogeneous reactions—reactions in which the reactants are not homogeneously mixed. "Simple desktop chemistry always includes a stirrer," says Raoul Kopelman of the chemistry department at the University of Michigan, Ann Arbor. "However, in geological reactions, or biological reactions, or reactions in the solid state or on surfaces, one cannot introduce a stirrer at will. Ninety percent of all reactions, including most industrial reactions, are, in fact, heterogeneous. They cannot be stirred efficiently."

One way such "understirred" conditions can be reproduced in the laboratory is to run reactions in a spatially confined domain. Examples include a one-dimensional environment (such as a wire or capillary) or an area of restricted size (such as islands of catalytic activity on an inert surface). In such environments, where reactants cannot be stirred and do not mix homogeneously, phenomena arise that cannot be modeled by classical theories of reaction kinetics. These fractal-like phenomena include anomalous (often fractional) reaction orders and time-dependent rate "constants."

The anomalies reflect a spontaneous self-ordering of reactants that is not accounted for in the usual analysis of such reactions. According to Katja Lindenberg of the department of chemistry at the University of California, San Diego, "If you look at the way textbooks describe the reaction, A + B → products, the supposition is that the reactants A and B are spatially mixed at all times so that a volume of any size, no matter how small, contains both As and Bs. This is what most chemists would assume to be the case for such a reaction, and this is the underlying assumption in the usual classical laws of mass action."

However, when such a reaction is carried out in a spatially confined domain, spontaneous segregation (self-ordering) of A and B into aggregates of like reactant species may occur. If so, the reaction can then only proceed at species interfaces. The effect of the segregation is to slow down the reaction relative to that of a stirred sample.

In a confined-domain reaction involving a single species, A + A → products, self-ordering is a tendency toward a reduction in the number of nearby reactant pairs. In the presence of a stirring mechanism, such pairs would be continually produced as a result of spatial "rerandomization." In its absence, the depletion of nearby pairs once again slows down the reaction relative to a stirred reaction.